CHAPTER - 2

GROWTH AND EMPLOYMENT, THEORY AND EVIDENCE OF TECHNOLOGY CHOICE AND THE METHODOLOGY OF THE STUDY

INTRODUCTION

This chapter discusses the importance of growth, employment, effeciency in technology choice. This has been related with the economic growth, population and employment problems of Bangladesh. It examines the importance of the textile sector in the manufacturing industry and highlights its future expansions to meet the growing domestic textile consumption. An attempt has also been made to project the future employment generation of the industry in relation to the projected growing labour supply. The alternative production process available in textile manufacture have been given considerable attention alongwith the implications of the choice of techniques to accomodate the growing unemployment problem. It discusses the theory on the choice of technology and examines as to whether there is a wide range of technologies available to choose from or only a few. It also considers the issue of the existence of technological rigidity. Literrature review which has been carried out in the International Forum and in the academic institutions on the choice of textile technology with particular reference to the developing countries and their increasing unemployment problem forms an essential component of this section. The overall view which has emerged from these findings is that technological choice is an emperical phenomenon and that a wide range of alternatives are available for the production of a defined quality and quantity of textile product. It sets out the methodology adopted for the study which comprises of the identification of the sub-processes which combine to form a total process technology. The methodology would also involve the costing of these alternatives and selecting the appraisal method and the criteria of choice for ranking these alternative technologies in terms of, for instance, Net Present Value (NPV), Present Value Cost/unit (PVC) and employment. Finally , it would focus on the requirement data that are essential for the evaluation of alternative technologies.

Growth, Employment, Effeciency and Technology Choice

The reason for underdevelopment in developing countries can be traced back to low level of income, low self-esteem and limited freedom. Low income results in low savings which means low investment, limited labour demand, high unemployment, low productivity and therefore low income in turn. Low level of living precipitates low self-esteem and limited choice. According to Rostow (1960) the transition from underdevelopment to development can be explained through a series of stages which all countries have to go through. 1/ The country has to mobilise domestic and foreign savings in order to generate sufficient investment to accelerate economic growth. To help growth, new investment representing net addition to the capital stock through savings is necessary, which would bring about corresponding increase in the flow of national output(GNP). Harrod-Domer theory of economic development states that the rate of growth in GNP is determined by the national saving and capital output ratio, where the growth is positively related to the former and inversely to the later. 2/ The trick of economic growth and development, therefore is simply a matter of increasing savings and investment. A constraint to this model was the relatively low level of new capital formation or investment in the very poor countries. Furthermore, it implicitly assumes the existence of necessary structural , institutional and attitudinal conditions in the developing countries. International-structuralist theory of underdevelopment rejects the exclusive emphasis on acclerating growth of GNP as an index of development. Instead, it puts emphasis on the much needed structural and institutional reform at domestic and international level. Professor Kuznets (1971) has given a comprehensive account of economic growth based on historical growth of national income of developed countries. He defined a developed country's economic growth under three principal components (a) the substantial rise of national outpu

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1/ Economic for a Developing World by Michael P. Todaro, Longman Group Ltd.,London,1977 p.88

2/ ibid., pp 89-90

(b) advance technology and (c) institutional, attitudinal and ideological adjustment. 3/ High rates of per capita income results from rapidly rising level of productivity. High per capita incomes in turn generates high level of per capita consumption, thus providing the incentives for changes in the structure of production from agriculture to manufacture goods. For significant economic structural change to take place , concomittant transformations in attitude, institutions and ideologies are often necessary. High level of productivity is maintained through the application of advanced technology. The historical experience of economic growth in the developed countries has limited value for developing economies. The fact is that the growth positon of the less developed country today is in many important ways significantly different from that of the present developed country, viz. low resource endowment, low per capita income, large population size, institutional rigidity, etc.

The pursuit of growth as the principal economic objective for the development came under close examination during 1950-1960s. The target of economic growth may be achieved , but povery, unemploy -ment and income distribution may remain the same. Since increased savings and investment are essential components of the growth process, an equality of income becomes indespensible as it assumes that it is only the rich who saves, while the poor spends all. This disparity , according to Harrod-Domer theory, appears to be justified from a long term perspective which is inherent and necessary during the ealy stages of growth. The national per capita income has to grow high enough to make possible sizeable redistribution of income via tax and subsidy. Until such time , redistribution would lower the growth. The emphasis is therefore on increasing the GNP and the per capita income. However, evidence indicates that two countries having the same level of GNP and per capita income may have entirely different production and consumption structure, i.e they may operate different points on the same production possibility curve depending on whether or not personal incomes are distributed equally. High rates of economic growth and rising levels of per-

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3/ ibid., p.111

capita income do not necessarily imply economic development in the sense of improved level of living for the mass of people, rather it can create rural to urban migration and a high level of urban unemployment. Emperical research have identified no apparent relationship between per capita income and the degree of income concentration. High per capita income do not themselves guarantee the absence of significant number of poverty. 4/ The problem of poverty and acute unequal distribution of income are not simply the result of national economic process , rather they depend on the character of a particular economic growth and the political and institutional arrangements according to which the rising nationa incomes are distributed among the broad segment of the people. Any attempt to alleviate this unequality would be identify the poverty group and their economic circumstances. Moreover, attempts to improve the living the standards of the poor significantly must therefore would be, among other measures, to focus upon the increasing of economic returns to the economic factors they possess i.e raising the returns to their labour through more employment.

The sustenance of economic growth and development in the developing countries brings out the problem of rapid population growth of these countries and its bearing on development. There are diverse opinion , especially in developing countries as to whether population growth is a serious constraint and many developing countries believe that it is an issue created by the developed countries to keep the developing countries dependent on them. They believe, underdevelopment is the real problem and development should be the only goal the achievement of which would take care of population growth. Some even argue that in some developing countries populatio increase is desirable to generate consumer demand and favourable scale of production to supply low cost labour for high level of output. Data available for 12 different countries show that there is no clear relationship between rapid economic growth rate and lower fertility level. 5/ Some have also quite forcefully stated

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4/ ibid., pp 239-40

5/ ibid., pp 172-74

that all development failures in developing countries can be ascribed to the rise in population and advocated its immediate control before expecting any development efforts to succeed. Howeve: ,the general consensus is that the population growth is not the primary reason for low living standards but it itensifies the problem of underdevelopment and makes the possibility of development remote. The development strategy should, therefore not only be to limit its further growth(population), but also to deal with the underlying social and economic conditons of underdevelopment.

An important aspect of the development process in the developing countries is the rural-urban migration, which has increase inspite of urban unemployment. Until the 1960s, the rural-urban migration was not of interest to economists. The earlier model of Lewis-Fei-Ranis that rural-urban migration is a self-adjusted mechanism, was based on the assumption that effecient allocation of human resources between the sectors (agriculture and Industry) is a natural out-growth of self-adjusting competitive mechanism, which functions to equate sectoral wage rate and productivity. In the 1960s and the 1970s, urban unemployment and underemployment emerged as a problem and the principal cause was found to be rural-urban migration. As rural-urban migration is the determinant of urban labour supply, therefore migration and the relative economic opportunity between the rural and the urban is central to the employment problem. The characteristics for migration were isolated and traced to three main sources,they are demographic, educational and economic. Although non-economic factors have relevance, but among economists the consensus is that it is economic factor that causes migration. With the assumption that migration is primarily an economic phenomenon, Todaro developed a model which states that migration proceeds in response to urban-rural difference in expected earnings for a given time horizon. 6/ He further explains that urban-rural migration in a full-employment is due to higher wages

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6/ ibid., pp 220-222

which will continue until the wage differential is reduced. But such a situation do not exist in developing countries which has chronic unemployment problem. Todaro argues that migration is possible even with high urban unemployment, because of imbalances in economic opportunities in developing countries between urban and rural area. Migration, therefore , has an important policy implication for development strategy with regard to wages and incomes, rural development and industrialisation. It has been suggested that urban job creation, educational facilities, wage subsidy and traditional scarcity of factor pricing are not sufficient to stop migration or urban unemployment , rather it is imperative that the imbalances between economic opportunities in rural-urban sectors be as much minimised as possible. A general consensus among the economists is that a comprehensive employment strategy need to be adopted which includes rural-urban economic opportunity and balance, expansion of small-scale labour intensive industries, elimination of factor-price distortion modifying direct linkage between education and employment and choosing appropriate labour-intensive technology of production.

Although, high growth rate do not necessarily assume income distribution without some institutional measures but sustenance in economic growth is necessary for development. Recent emperical evidence suggest that high growth do not necessarily worsen the distribution of income as some has suggested. 7/ It is essential for the sustenance of economic growth that investments made should economically effecient i.e they should be able to generate surplus. This surplus or re-investable fund is required by the economy for future investment to help sustain long-term growth and employment. The experience of the last two decades has been that the developing countries have directed their re-investable funds towards the modern manufacturin and commercial sectors in the urban areas. Todaro

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7/ ibid., pp. 151-52

reasoned from these experiences that the intention of modern urban industries to create significant employment opportunities had failed to meet the development objective to maximise employment. Many of the developing countries were observed to have experienced 10 to 15 per cent unemployment in the modern sector,whic was further aggravated by population growth. He forwarded examples of the manufacturing sectors of the developing countries which have an annual growth rate of 6 to 10 per cent with a subsequent rise of employment opportunities only by 1 to 3 per cent. 8/ It is an obvious indication of the failure of the manufacturing sector to provide the necessary employment needed to absorb the growing labour force. Bruce and Garg went as far as to suggest that,the adoption of modern technology in textiles has disrupted the traditional infra-structure leading to a collapse of traditional production, indigenous craftsmanship and artisan growth. 9/

It therefore emerges, that, though the modern production technology could be economically rewarding but it is characteristically unsuited for the social and economic conditions of the developing countries. Furthermore, development of the manufacturing capability of a country only through modern sector is not likely to generate sufficient employment to accomodate the ever-increasing labour force in the developing countries . As Boon has pointed out, it could create a duality in the economy, comprising of a small modern sector concentrated in and around the city and a large uneffected semi-urban and rural sector creating an imbalance in the economy.10/ With this in the background, fresh attentions were given in the late 1960s on the implications of employment in technology of production in the textile industry and has been regarded as an important area of study.

8/ ibid., p.206

9/ Project Report and Feasibility Study on Appropriate Technology for Cotton Yarn Spinning on Cottage Basis in Rural Areas by M.K.Garg and Robert Bruce, Appropriate Technology Development Association,India,1978 p. 22

10/ Dualism and Technological Harmony for Balanced Development, by G.K.Boon, UNIDO, Vienna,1978

It has been argued in some studies that the organised method of production in the modern sector has a relative advantage over the traditional technology in terms of economic effeciency and growth, however, its inability to generate sufficient employment to resolve the growing unemployment in the developing countries questions the unequivocal choice of modern technology. Therefore, with the present population and unemployment problem it is to be questioned as to whether the developing countries should continue with their traditional method of production or should they opt for higher technology. 11/ There is undoubtedly a conflict between economic effeciency and employment, which emerges from the production technology to be adopted. A possible solution to the problem is a trade-off between employment and economic effeciency. Technology choice provides with a measure of this trade-off which may furnish unnecessary sacrifice of economic effeciency or surplus to create employment. Technology choice, therefore, needs a close examination of technical and economic characteristics of the production methods and the technology available. Traditionally, the developing countries are dependent for their production technology on the developed countries. As has been experienced that uncritical choice of these technologies have proved to be inappropriate in the developing coutries with their factor endowments and economic conditions. Francis Stewart pointed out that the advanced technology originated mainly in the developed countries, the process development and the technical features have incorporated the essential economic and social conditions of these countries. As the labour wage rate in the developed coutries went through a continuous increase, technological development under this condition evolved machinery with much higher operating speed and productivity and less labour requirement. An outright transfer of this technology to the developing countries with their rich labour endowment and growing unemployment problem proved to be highly inappropriate.12/

11/ Appropriate Industrial Technology for Textiles, UNIDO Monograph No.-6, New York,1979.

12/ Technology and Employment, by Frances Stewart, The Macmillan Press Ltd., London, 1978.

It enquires as to whether the developing countries have a large number of alternatives to choose from or just a few or even if there is technical rigidity of choice. This would be examined later under a theoretical framework substantiated by emperical evidence especially from the textile production point of view. However, prior to that , it would be useful to examine the aspects of population growth and unemployment against the present level of economic growth in Bangladesh and the role of the textile industry.

Growth, Population, Employment and Textile Production in Bangladesh

It appears from chapter- 1 that the rate of growth of GDP for Bangladesh during FY 1972 to FY'81 fluctuated between 1.9 to 9.4 per cent. However, the per capita growth was relatively less and it was minus 0.4 to plus 6.9 per cent during the same period. In terms of absolute increase , the real per capita income increased between Tk.612 to Tk.769 between FY 1972 to FY 1981 i.e an average growth rate of 2.27 per cent annually. The reason for this low growth, among other things is the high rate of population growth. The population census of 1981 shows that during 1961-81 the rate of population increase was 2.5 per cent per annum which gave rise to a increase in labour force by 3.1 per cent. Therefore, the importance of population increase and the consequent rise in labour force has significant implications on employment, industrial growth and the technology of production.

There are a large number of population projections based on different sets of assumptions . The estimates made by them also vary considerably. A comparative study by the Chr. Michelsen Institute,Norway,suggest that these projected estimates could vary from 100 to 160 million in the year 2000.13/ It, however, says that a

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13/ ' Population Projection for Bangladesh 1980-2000 ' by John Skutle and Per Tveite, Derap Working Paper, Norway, June, 1983. pp.2-3.

population of 117 million could be the lowest estimate while 160 million the highest in the year 2000. For practical planning purposes, the study believes, 143 million might be a reasonable compromise. It would be convenient here to use the projections made by the World Bank, because it also relates population growth with the growth of labour force. A summary of the World Bank projection is given in the table 3.1 below:

TABLE 3.1

Population Projection and Labour Force Growth Rate, 1980-2000

Population & Labour Force/Year	1980	1985	1990	1995	2000
Population(million)	89.6	101.4	113.2	124.2	134.2
Growth Rate(percentage)	2.5	2.2	2.1	1.5	-
Labour Force(million)	28.7	33.0	38.7	45.3	52.8
Growth Rate(percentage)	3.1	2.8	3.2	3.3	3.1

Note : Assuming that Net Reproduction Rate = 1 will be reached by the year 2000.

Source: Short-Term Outlook, World Bank, March,1980, p.79 and Bangladesh : Recent Economic Trends and Medium Term Development Issues, World Bank, March, 1983, p.110.

It appears from the table 4.1that the rate of population growth during 1980-2000 will drop from 2.5 per cent to 1.5 per cent, while the growth in labour force will remain at 2.8 per cent to 3.3 per cent. It is therefore, clear that the growth in labour force would not be less than 3.1 per cent until 2000. Despite the present state of employement(i.e whether there is unemployment or under-employment), the absolute growth of labour force at this rate would pose a considerable problem for the country.14/ It could be

14/ The concept of employment is quite complex in a non-wage labour economy,see Employment,Technology and Development by Amartya Sen, Oxford University Press,1975,pp.3-10, the relevant figures available from Pilot Manpower Survey,1979,Bureau of Statistics,Bangladesh is not illuminating.It estimates the economic participation o population aged 10 yrs.or above in 1979 as:Civilian labour force: employed 53%, unemployed- 0.8%; Others : household work-36.8%, and inactive 9.4%.

appropriate here to refer to an example cited by Pickett, which has some resemblance to Bangladesh situation, where it is assumed that if the initial distribution of labour force was 80:20(agriculture and manufacture), and if this force was to grow at an annual rate of 3 per cent for 15 years, annual increases of 0.5 per cent and 1.0 per cent in those employed in agriculture would require the non-agricultural labour to grow by 8.6 and 7.9 per cent respectively,if un-employment were not to emerge.15/ Similarly, an example put forward by Todaro suggests a developing country whose modern industrial sector employs 10 to 20 per cent of the labour force, it would need to in crease employment by 15 per cent per annum just to absorb the increase in its total work force growing at 3 per cent per year. 16/ These illustrations have particular relevance to Bangladesh situation, where about 74 per cent of the people are directly employed in agriculture and 11 per cent in the manufacturing sector. They emphasise that under the present condition of agriculture production, its sectoral contribution to the GDP has declined during FY 71-FY 77 from 64 to 56 per cent and remained virtually constant till FY 78, therefore, the growing labour force need to be accomodated in the non-agriculture sector. However, the GDP contribution of the total Industrial sector which also includes small-scale industry had a marginal increase from 11 to 14.5 per cent during FY 72- FY 81 (see chapter 1). Furthermore, the average annual growth of employment experienced was 6.1 per cent(see table 1.26) which falls far short of the employment creation target required to absorb the growing labour force. This poses a policy problem as to whether the manufacturing industry would in future be able to contend successfully with this growing unemployment problem.

So far, it becomes apparent from the discussions that in the presence of virtual stagnation in agriculture output and employ-ment opportunities in that sector, the manufacturing industry

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15/ A Report on a Pilot Investigation of the choice of Technology in Developing Country, by James Pickett, David Livingstone Institute of Overseas Development Studies, University of Strathclyde, 1975, p.7

16/ Economics for a Developing World, op. cit., p.206

need to play an important role in employment generation. This brings us to a direct confrontation with the issue of technology choice in the manufacturing sector. Uncritical choice of modern technology is often in conflict with the surplus generation which is essential for continuing economic growth and employment creation. 17/ It would eventually depend on the planning objective of the Government to decide whether the need for employment generation is more pronounced than for economic surplus. As has been discussed already in chapter 1 (see 1.3.4) the present emphasis given in different planning documents is on the optimum use of labour factor in relation to capital factor which is scarce. The use of local factor endowment viz. labour has been advocated and has been argued that it should not be replaced by scarce capital in those industries where such substitutes can be avoided. 18/

Textile being the second largest manufacturing industry with a contribution of 22.6 per cent of total added value and 16.5 per cent of the total industrial employement/could play an important role in the future employment generation of the country. In FY 81 Bangladesh imported 38 and 6 per cent of its yarn and fabric respectively(as already mentioned in chapter 2, section). Further calculations indicate that to meet the planning target of 1985 which is 12 yards of cloth per capita(see table 2.30) Bangladesh would require an expansion of spindle and loom capacities to 865,440 and 14,882 respectively. This is expected to ensure self-sufficiency in domestic production of cotton textiles to meet the 1985 consumption level. Calculations also suggest that it would be required to install or bring into operation another 200,000 handlooms, if the cloth requirement is to be met by handloom only. The computations clearly illustrate that if the cloth requirement is to be met by domestic

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17/ Appropriate Industrial Technology for Textiles, Monograph-6, op.cit., ' Production of Cotton with Special Reference to African Condition, by J.Pickett and R.Robson, pp.33-34.

18/ First Five Year Plan(1973-78), Second Two Year Plan(1978-80) and Second Five Year Plan(1980-85), sections on ' Industry and Development Strategy ', Planning Commission, Government of Bangladesh, Dhaka.

production and with modern technology , the country then would have to set up 35 composite (spinning and weaving) units which would create direct employment for over 50,000 people.

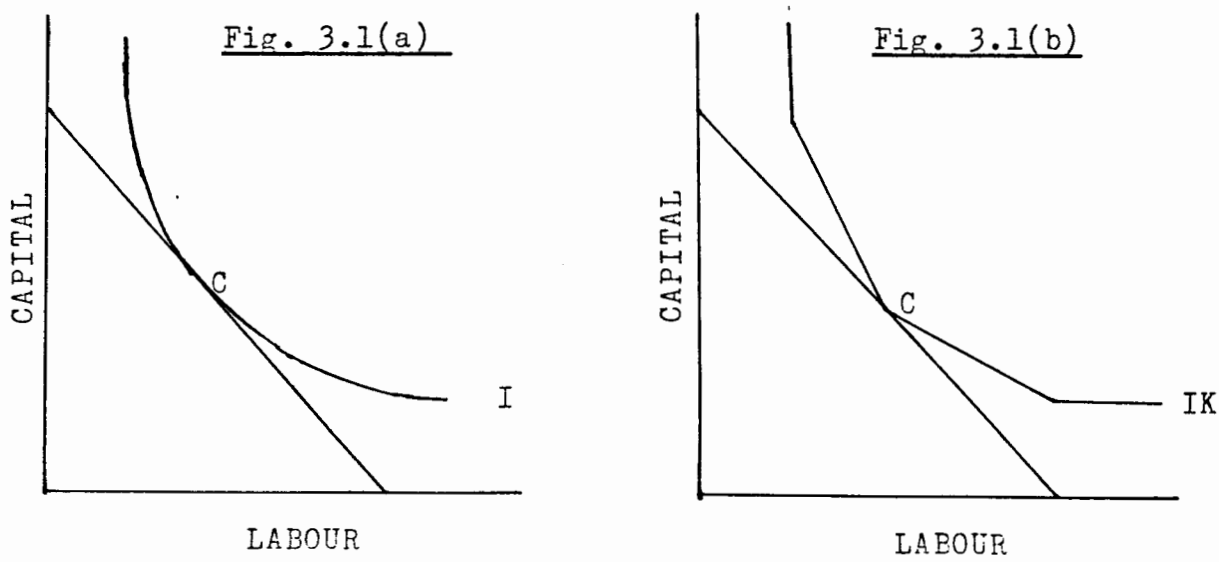
With such an expansion possibility of the textile industry, the choice of technology would certainly play an important role in providing optimal employment in this industry . Moreover, the process of textile production is unique in a sense that there are a number of alternative manufacture technologies to choose from. These methods could range from simple tools like the hand-spindle and handloom to highly sophisticated power driven spinning and weaving machinery, viz. open-end spindles and shuttleless looms. A product could be manufactured either in the organized sector under factory condition (organised sector) or in a smaller factory unit (decentralised sector) or even in a cottage type unit (traditional sector).However, the employment which would be created by these alternative methods of production could vary to a large extent. 19/ It needs to be mentioned that the labour force has been considered easier to train in the textile industry than in most others. The product quality which varies according to the type of technology in many industries suffers relatively less in the textile industry, at least as far as coarse to medium textile products are concerned. Presently, over 90 per cent of the textile products manufactured in Bangladesh are of coarse to medium type (see chapter 2). Therefore, from planning point of view a detailed study of this industry with special emphasis on the methods of production and their employment aspect could be of immense interest. Such an exercise would help to ascertain and question the present policy of this industry, and should hopefully provide a sound footing for the formulation of policies for future expansion and development of the textile industry.

19/ UNIDO Monograph - 6(1979), op.cit, Pickett and Robson, pp.31-35. This study shows that to produce an output of 28 million sq. yds. annually, the four alternative technologies available could have an employment variation between 1,245 to 48,000.

Is There Any Choice of Technology ?

The neo-classical economic theory suggests that a choice of techiques exists. In economic terms, such a choice takes the form of various combinations of capital and labour to produce a well-defined output of a definite quality. Thus the elasticity of substitution between capital and labour has been considered as the important aspect in determining the range of choice in technology. Variation in the **elasticity** of substitution is a direct response to the variation in the relative prices of labour and capital. If labour and capital are the only two factor inputs for production then in a profit maximizing situation equilibrium will be reached when the marginal product of the two factors is equal to factor price ratio. In two factor input production function, the functional relationship between the physical inputs (i.e labour and capital) and physical output can be of many form, however, from the neo-classical point of view the interest lies on the variable proportion of production function, generally known as an ' Isoquant', which is in the form of a smooth convex curve for a defined output and may be as illustrated as in figure 3.1 below :-

FIGURE 3.1



The Isoquant (I) represents a series of technologies available

along it for a defined product and quality. The relative factor prices determine the price line which meets the Isoquant at a point which decides the production technology. It is clear from the isoquant that if the relative price of labour falls, then the choice would be situated at the right-hand side of the curve i.e the chosen technology would be labour intensive. Conversely, if the relative price of capital goes down then the technology would be capital intensive. At a given per unit price of labour and capital for a fixed amount of investment , the optimum choice would be at the point where the factor price line forms a tangent on the isoquant curve which is 'C'. The other important features of isoquants are exhibited by a series of isoquants moving outwards for higher output and conversely inwards for lower. However, in a situation where the production technology has improved, the isoquant for the same output could move inwards from its existing position. This brings forth the notion of 'technical ineffeciency' i.e it indicates that the technology which require more of one factor input but not less of the other input than its alternatives, such a technology is considered to be ineffecien , which could be represented by technology 'R'.

The neo-classical model of technology choice suffers from a serious simplification of the characteristics of the factor inputs, types of available technologies, quality of output,etc. It assumes that both labour and capital inputs are homogenous and that their characteristics do not alter with technology types and increase in output. Such characteristics of undifferential labour and physical capital assist in the easy substitution of labour and capital. The neo-classical assumption of variable proportion of production functions though widely used has been contradicted by many authors who have emphasised that the choice is not as wide as suggested by the theory. Arrow et al argue in favour of the neo-classical model and affirm that choice options are infinite. From their study of 19 countries comprising of 24 manufacturing industries, they have established that there are varying degrees of substitutability, and that technological alternatives are numerous and flexible in some sectors , but

could be limited in others. 20/ The existence of a wider range of choice similar to the neo-classical approach has been suggested in a method developed at the David Livingstone Institute. It has been established that a range of alternatives could be obtained by combining different sub-process technologies with varying labour and investment compliments. It is possible to construct an isoquant with these alternatives which could be in the form of a smooth convex curve. 21/

Contrary to what has been proposed in the neo-classical framework, Eckaus proposes that the choice is limited. Whatever little choice exists, is concentrated at the capital investment end of the technology spectrum. Besides this, choice could also be excercised through the choice of products. His arguments can be represented in the form of a heavily kinked shaped production curve (Figure 3.1(b)) and in the extreme case would indicate ' technological determinism ' or rigidity. 22/ Stewart also maintains that there is no technology choice, but his arguments have been based on technical progress. He argues that the developed techniques which survive reflect the economic condition of that time, and therefore, rather than a complete isoquant corresponding to each period of time for each scientific and technical age, there is a series of techniques developed at different times with a tendency for the earlier one to become technically ineffecient or even obsolete. 23/ Therefore, the isoquant is in practice not a smooth curve but a discontinuous one. He also believes that the assumption of identical nature of products has some limitations. Technology with higher capital proportion tend to bring forth better quality product than that with lower investment content. He further argues that as techno-

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20/ 'Capital Labour Substitution and Economic Efficiency'by Arrow,K.J., H.B. Chenery, B.S.Minhas and R.M.Slow, Review of Economics and Statistics, Vol. XLIII,August,1961.

21/ A Report on a Pilot Investigation of the Choice of Technology in Developing Country op.cit., pp. 51-55

22/ 'The Factor Proportion Problem in Underdeveloped Areas',by Eckaus,R.S., American Economic Review, Vol. XLV, September,155.

23/ Technology and Underdevelopment, op.cit., pp.10-29.

logy choice along neo-classical lines is the result of the survival of earlier labour-intensive techniques alongwith the later more investment intensive ones, any choice between them would involve a choice of scale, skills, etc on the whole, as production on a smaller scale require less skills and less technologically advanced inputs as compared with the later techniques,

On the other hand the neo-classical arguement could although be restored to a certain extent. Salter (1966) believes with the neo-classicists that potentially there exists a whole range of techniques with varying intensity of labour and capital corresponding to each level of scientific and technical developments. But from this large potential range only the immediately profitable were developed. 24/ He contrasted the view that, only a narrow range of developed techniques are actually available. Salter refers to the role of the machinery suppliers and notes that whatever technology options there are, could be traced from the types and characteristics of machinery and equipment in current supply. This gives rise to a somewhat kinked isoquant rather than a smooth one. Salter's theory thus suggests that there is a scope for technical choice the range of which would depend on the sector of the industry under consideration. The scope of this study is to establish the evidence of technology in the textile industry. Therefore, the next section would throw light on some of the emperical evidence that has been established on the choice of technology within the modern, intermediate and the traditional sectors.

Emperical Evidence on the Choice of Technology in Textiles

It has often been suggested in literatures that the textile industry required more labour per unit output than many other industries and even in the highly capital intensive ones of the industrialised countries. In developing countries, textile industry is important in terms of value added and the employment it creates. A knowledge of the production technology of this industry is therefore important. It is the availability of a wide range of technology with different intensity of factor uses which makes this industry an important area of study. A number of studies have been carried out to enquire into its production process and

24/ Productivity and Technical Change, by Salter, W.E.G and W.B.Reddaway, Gambridge University Press, 1966 pp 13-26.

the labour substitution possibilities in order to identify the alternative technologies available. The literature on the choice of techniques in textile may be categorised as follows :

i) literature on the organised sector which investigates the factor substitution possibility within the modern technology using the machinery available.

ii) literature on the organised and decentralised sector which gives a comparative evaluation of modern, intermediate and cottage technologies

Literature focused on modern technology often used well-defined economic criteria to arrive at a choice and then to emphasise the choice on the grounds of economic surplus as well as employment. While literature on the decentralised sector often makes the evaluation without proper economic criteria giving more emphasis on employment and socio-economic background of the country. Employment and sustaining existing employment overshadow economic effeciency.

Literature on the Organised Sector

To discuss a few of the studies on the organised sector, the best point of departure would be to start from the United Nations Monograph - 7 published in 1969. 25/ The Monograph devotes itself on the aspect of modern technology and sets out some technical and economic factors which affect choice in the developing countries. It also reviews some of the issues and recommendation of the International Symposium which was held in 1967. The Monograph further emphasises the importance of textile industry in the developing countries in the face of growing domestic textile consumption and export possibility, but however, considering the role of import substitution as secondary. It relates capital-labour ratio and wage cost with the economic size of the unit which is believed to increase with the rise of the ratio and wage rate and decrease with lower wage rate and ratio. 26/ The report maintains that in the developing

25/ Industrialization of Developing Countries : Problem and Prospects- Textile Industry, Monograph -7, United Nation, New York, 1969.

26/ ibid., pp 41-42; An OECD study published in 1965 showed that a modern textile mills in Western Europe working on 3 shift required a capital investment $ 15,000 to $ 25,000 per employee and that a mill with 10,000 spindles should be regarded as the minimum balanced unit. In Canada, where labour cost are higher, the investment cost per employee is about $ 38,000 and minimum economic unit would be in the range of 20,000 to 30,000 spindles. In USA, the Capital/Labour ratio reaches $ 50,000 per employee.

countries , factory production even on the smallest scale is likely to produce cheaper cloth than with handlooms in the cottage industry like those in India, because a large number of those employed in this industry are in the rural areas and therefore the sustenance of handlooms is not strictly economic. In the selection of machinery it recommends that at each stage of production a combination of labour and capital should be made in such a way so as to provide optimum result. To comply with the factor cost of the developing countries, unnecessary automation could be avoided, as automation is required only when high quality product is desired. As the developed countries experience a rapid development of technology they may find their technology obsolete in five years time. This technology could then be successfully used in the developing countries to suit their factor cost and thus save scarce foreign exchange. The Monograph also proposes that, the modernisation of existing units could be economically worthwhile and time-saving instead of setting up new units. It finally argues that, it could be possible to combine a highly capital-intensive spinning mill operating on a large scale with several small scale labour intensive weaving mills, as the application of labour-intensive production method is greater in weaving than in spinning. In an earlier UNIDO study (1967) some of the technological and economic aspects of setting up of textile mills in the developing countries have been elucidated. 27/ It gives similar treatment of the issues discussed, viz. economy of scale, modernization and selection of machinery. Moreover, it relates the importance of economy of scale with the quality of yarn and fabric to be produced. The number of machine at process level would be determined according to the production plan, the study therefore contends that investment cost is variable with the quality of product. Investment cost is reduced with higher quality yarn and fabric, but this variation is less significant in the case of fabric quality.

27/ Technological and Economic Aspects of Establishing Textile Industries in Developing Countries, UNIDO, Vienna, 1967.

Another UN study known as the ECLA study (1966) which preceded the two research works discussed, was perhaps the first to focus attention on the micro-level quest for alternative technologies in the modern sector. 28/ It identified three levels of technology according to the technology vintages : 1950 (A), 1960 (B) and 1965 (C). The study recognises the sub-process level combination of different vintages and mentions a possible 177,000 technologies. However, it evaluates only a limited number of technologies and determines the utmost economic combination from the stand point of production cost or with least reduction of manpower, but giving greater return on capital. The choice of technology, it believes,can not be selected based on the generation of economic surplus alone, social aspects of choice and value judgements are also important points of consideration. It,therefore, argues that the highest return on investment could be defined as maximization of benefit in the form of highest product-capital ratio and employment level. To arrive at technology choice in textile manufacture at the Latin American factor cost the methodology has defined a product and economic size of plants to enable comparison accross the technology vintages. 29/ It emerges from the research that accross the technology, the employment level experiences a sharp fall for advanced technology, but this decrease is more significant in the case of unskilled rather than skilled labour. Furthermore, It has been observed to be more pronounced for spinning than for weaving. For technical and administrative staff, however, employment level increased where advanced technology is concerned. 30/ The capital-labour ratio and gross-value added of the three vintages mentioned in the ECLA study varies

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28/ Choice of Technologies in the Latin American Textile Industry, by United Nation Economic and Social Council,Chile,1966

29/ ibid., Product types : 18 english count yarn for warp(ends) and weft(picks), 36 inch width and 52 end and picks per inch. Economy of scales: Plant A(1950) - 13,600 spindles; Plant B(1960)- 15,000 spindles,and;Plant C(1965) - 14,820 spindles.

30/ ibid.,Employment indices for Plants: (a) Operatives : A(100), B(57) & C(57); Technical and Adminstrative Staff: A(100), B(84),and C(112).

immensely, affirming that the capital-labour ratio of technology C was three times higher than technology A, while the gross-value added was one-third of technology C. It is interesting to note that unlike the UNIDO study (1969), the economic unit size did not vary in accordance with the variation in capital-labour ratio, 31/ therefore, indicating that the size of unit is more likely to be variant with wage rate rather than capital-labour ratio. This is possibly due to the identical economic size fact that differential wage rate was not taken into consideration in Latin American countries. The study found that at Latin American factor price, technology 1960 (intermediate technology) offers largest reduction in investment cost and is the most suited technology, but, if the objective is to maximise employment than technology A should be chosen. 31a/ This technology choice is found to be insensitive to the possible rise in capital and labour cost. 32/ The study states that the micro-level emphasis of choice would be on surplus generation, and goes on to point out that the two points of view, one emphasising the importance of maximum production and the other the re-invetable profits are conflicting. Nevertheless, one cannot be ignored completely without endangering the other. It shows that the product-capital ratio declines as the process becomes more capital intensive. Technology A offers a better choice in terms of higher capital productivity and higher value-added but does not offer higher re-investable profit, therefore higher growth rate. Technology with higher value-added is likely to have better income-distribution effect. Rejection of technology A was on the grounds of lower reinvestable surplus and technological obsolescence. Technology C on the other hand, has lower capital-product ratio, but generates the highest surplus and would be preferred by private entrepreneurs. However, from the social point of view

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31a/ ibid.; Fabric cost per unit decreased by 10 per cent from A to C, while 7.7 per cent for A to B and by 2.9 per cent for B to C respectively.

32/ ibid., although the capital and labour costs were increased by 16 and 70 per cents, technology B remained the best choice.

31/ Capital/labour ratios of technologies A,B and C are $6,600, $12,700 and $20,000 respectively.

technology C would be a costly choice under the present un-employment situation, rather technology B would be chosen as the differential in profitability between B and C is less significant than employment creation. The study therefore examines the choice available for Latin American countries from the range of technologies available from different sources and concludes that the technology vintage of 1960 would be most suitable under the factor availability and prices at Latin American economic condition. The work, however, ignores to reflect on the choice of second-hand machinery.

Pack (1976) maintains that there are sufficient quantity of second-hand machinery available in the developed countries which could be effeciently substituted to suit factor prices of the developing countries. 33/ This was in fact one of the issues discussed in the UNIDO Monograph-7 (1969). Park pointed out that the arguement for the developing an 'intermediate technology' adapted to the factor condition of developing countries is a time consuming exercise, rather it would pay off to use second-hand machinery for the immediate unemplyment problems. Almost similar to the ECLA study, he considered spinning alternatives of vintages 1950, 1960 and 1968, while for weaving he took automatic battery and unifil and shuttleless(Air jet and Sulzer) looms. He has considered exclusively a complete list of machinery, power requirement, material wastage, space and finally labour requirement of the technologies. The choice of spinning technology from among the technologies mentioned was based on an identical product of 20s count with capital cost of 9 and 19.5 per cent. The price of second-hand machinery (1950) is 10 per cent of 1968 machine and has a project life of 10 years. The identical life of second-hand and new machinery was based on the assumption that the developing countries have local workshop facilities to maintain these machinery at a lower cost, while the maintenance of new machinery would be expensive. This differential maintenance cost structure would compensate for an identical project life. The analysis provides the estimation of an

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33/ 'The Choice of Technique and Employment in the Textile Industry', by Pack,H. , Technology and Employment in Industry,(ed) Bhalla, A.S., International Labour Organisation, Geneva,1976.

average hourly wage rate W*, at which 1950 and 1968 technologies would have an identical average total cost. At wage rate below W*, the 1950 technology would be less expensive as it is more labour intensive. Pack has also furnished an estimate of prices at which new models of older design have to be available to constitute an economically rational choice. The findings of his study reveal that at an interest rate of 9 per cent ,the estimated average annual wage rate W* is found to be $530, which compares favourably with the Indian and Pakistani wage rate of $364. Thus the use of second-hand equipment can be certainly justified for atleast some of the developing countries. His study further states that if the wage rate is found at $300 per annum, and capital cost is 9 and 19.5 per cent than the maximum value which can be paid for second-hand machinery is 30 and 55 per cent respectively. An increase in capital cost or decrease in break-even wage W* or the price of second-hand machinery would make the 1950 technology economically more attractive. Pack refers to the other issues as discussed in the UNIDO Monograph-7 (1969) such as the modernisation of equipment and the avoidance of unnecessary automation to complement the developing countries' factor cost. He concludes that unmodernised 1950 machinery remain most profitable than the modernised 1950 and 1960 technologies . As regards automation he disputes that contrary to the UNIDO and ECLA studies, automated material movement provided better quality product and showed by a comparative analysis that there were very little changes in the number of ancillary workers accross the technologies, while direct workers have decreased for the 1950, 1960 and 1968 technologies from 100 to 60 and 37 respectively. This reduction in direct labour,however, corresponds to the ECLA study. As for weaving, he concludes that the ordinary Lancashire loom at 9 per cent capital cost and 10 per cent as the price of new battery loom would be the best alternative for the developing countries. This loom is also known to provide four times more employment than the Sulzer loom. However, Pack expresses in accordance with the UNIDO research (1967), that the choice of technique do not depend soley on factor proportion and factor price, specification of the product is very important. The relative effeciency of the technique may vary considerably according to the range of product, for example ordinary Lancashire loom could be an effecient technology

for shirting and sheeting materials,but for Zephyr fabrics,shuttleless loom are regarded as the most competent technology.Finally, he discusses the aggregate employment effect of selecting a technology with lower capital-labour ratio, which could have direct and indirect employment effect. 34/ The direct effect is the selection of labour intensive technology itself, while the indirect effect resulting from the savings in initial capital expenditure because of lower capital-labour ratio,which could be employed to generate further employment from investments with identical or lower labour-capital ratio.Such effects calculated for a Phillipine textile industry of 1970 with an output level of 42,000 tons of yarn and 227 million sq. yds. of woven cloth, shows that instead of using 1968 spindles and new battery unifil looms,if 1950 spindles and Lancashire were used than the direct employment would increase by 100 per cent i.e from 4,100 to 8,200, while the rise in indirect employment could be as high as 92,000. The overall view of this study is that the developing countries should,for the immediate solution of their employment problems, make use of second-hand machinery which can be procured from the developed countries at a very low cost rather than engaging themselves in'intermediate technology.' However, Pack recognises that a developed technology could be an effecient alternative to older machines, but the evolution of it he believes is a time-taking process.

Pickett and Robson (1977) reviewed the two well-known studies of ECLA and UNIDO on textiles in order to examine the relationship between technology and employment in the developing countries. 35/ They have constructed three technologies relating ECLA and UNIDO technologies of 1950 as Conventional and 1965 as Intermediate and Advanced technologies.By categorising textile processes into four sub-processes and then replacing conventional process in an orderly progression

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34/ ibid., pp. 168-169

35/ 'Technology and Employment in the Production of Cotton Cloth', by Pickett, J. and R. Robson, world Development, Vol. 5, No. 3, UK,1977, pp. 205-215.

by intermediate and automated technologies for the four processes, they have identified 256 technologies. Out of which 81 were represented by an Isoquant, and finally 8 effecient technologies were identified. 36/ A comparison of these technologies were made based on 20 million sq. meter as annual output, however, to make the ECLA and UNIDO studies comparable output and quality taken were adjusted.

It was discovered that the capital and labour per unit output for the conventional and intermediate ECLA technologies were much higher than for the UNIDO. The relative ineffeciency of ECLA technologies were due to lower machine speed and utilization, higher machine price and less use of labour due to higher manning rates. The findings suggest that the developing countries are capable of using sophisticated equipment more efficiently than the less sophisticatd ones.

A comparative economic evaluation taking into consideration all factor inputs and skill for technology in three different wage areas, suggest that 10 technologies can be found to be technically effecient for high wage area (Europe) when for medium (Latin America) and low (Africa) wage areas they are 9 and 8 respectively. Technology choice varies according to the criteria of least cost or rate of profit, however, the variation in profitability is much less than the variation in employment, for instance the choice of technology with a profit variation of 2 per cent could create 52 per cent jobs under African wage level. Taking both criteria into account, technology selected because of either one of the criteria falls under high capital-labour ratio spectrum. Elasticity of substitution were calculated for different wage areas which lie between 0.2 and 0.25 for Europe, 0.25 and 0.33 for Latin America and 0.33 to 0.5 for Africa. This low elasticity of substitution confirms the earlier results that technology choice accross the wage areas are narrow and lie on the upper level of the capital-labour spectrum. However, these values, as Pickett and Robsons pointed out are much lower than the calculated values of Pack. Although the assumptions in the both the studies were based on constant elasticity function, but Pack's study ignores possible differences

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36/ ibid., pp. 206-207.

in technology. Further, Pack may have undertaken random comparison of technologies, which could be an explanation for arriving at such a high elasticity of substitution. The study further attempts to relate between efficiency and factor pricing in the designing of employment promoting policies and finally discusses the consequences for employment of increased effeciency. It argues that the scope of capital-labour substitution could be exploited from a public enterprise point of view, for which it would require a correction of wage rate of 38 per cent lower or 62 per cent higher than capital cost in order to initiate private entrepreneurs to make some choice. These are relatively large magnitudes and it would be easier to subsidise employment. Finally, the study concludes that an increase in effeciency in African situation would reduce both capital cost and employment by 38 and 36 per cent respectively without effecting the total output, it provides a quantitative measure of African ineffeciency.

In a later study, Pickett and Robson (1977) concentrated in more details on the operating conditions of the African textile production so as to relate productivity with the choice of technology. 37/ For spinning, six factories from two African countries A and B with different vintages were considered. Variations in vintages were taken care of by taking into account the prices of equipment with technology progress. The analysis shows that per unit output of capital is higher in African than in Europe in the proportion of 1.3 to 1.55 times and labour per unit output is 3 to 10 times higher for country A and B respectively. In Africa, effeciency is lower due to lower spindle-speed and higher yarn breakage which require more manning. It is interesting to note here that in the two countries, capital and labour productivity varies considerably. The mill found in country A could be comparable with those in Europe in terms of capital, labour productivity and management policies. The productivity differences can be explained by differences in technology type and management. As regards weaving, the machine sources ranges from Europe, Japan, India and China. The speed of Chinese shuttle loom was found to be similar to the cheapest European looms. Differences in machinery sources and their price complicate the productivity comparison on the capital side, for example capital per unit of output, if the European machinery prices be used the ratio is higher in Africa than in Europe, but when

37/ 'A Note on Operating Condition and Technology in African Textile Productinn', by Pickett, J. and R. Robson, World Development, Vol.5, No. 9/10, UK, 1977, pp. 879-882.

Japanese machine prices are being used then capital per unit of output is lower in Africa than in Europe. If differences in looms be ignored, an alternative measure of capital needed can be had by taking the no.of looms. On this measure more capital is generally needed in Africa than in Europe. Labour per unit of output is about 2.5 to 4 times in Africa than in Europe, however, exception to the one factory in country A which uses even less labour-force than Europe. Shuttleless looms are being used in Europe rather than conventional automatic looms, it increases capital cost per unit ouput to 100 per cent but at same decreases the labour input by 75 per cent. The paper concludes by underlining the fact that technology choice has ultimately to be from the point of view of country, productivity and firm specific.

The most important and micro-level choice of textile techniques of cotton cloth production have been proposed by the same authors in a more detailed study (1981). 38/ The study identifies the 'Least Cost Technology', the most labour-intensive technology and that technology which has been termed as the least cost one provides the maximum additional employment at a minimum additional cost(second best technology) at three different wage areas viz. high, medium and low. The methodology used was developed at the David Livingstone Institute by the same author. 39/ The work essentially defines a product, output level, life of the project and a discount rate at which the

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38/ The Choice of Technology in Production of Cotton Cloth, by Pickett, J. and R. Robson, Scotland Academic Press, Edinburgh, 1981.

39/ The methodology known as 'DLI Method' essentially identifies different sub-processes or work stations in a complete production process. The number of machines of a given type and capacity at each sub-process depends on the overall throughput of the plant. Each machine implies for example a specific level of other inputs(labour,fuel,etc.),a specific holding of spares and specific provision of floor space. The choices given at each sub-process are assumed to be technically independent of choice of other sub-processes, so that they can be combined with any alternatives at subsequent sub-processes without effecting product quality. At a set of factor prices,the cash-flow with each alternatives can be be calculated for each sub process level. Discounting these, provides a method of identifying least-cost technology at each sub-process, and combining the minimum cost sub-process option yield the commercially most attractive complete process.

alternative technique, investment and operating costs are to be deducted over the life of the project. The technique with minimum cost has been defined as the 'Least Cost Technique'. For textile processes, the study identifies eleven independent process-level some of which further generates alternative method of production. It also distinguishes more than 2,000 technically feasible technologies, all of which are capable of producing the defined product. The study concludes with an emphasis on the need for individual industry (micro-level) studies rather than relying on highly aggregated data and economic anlysis for the purpose of technology choice. It contradicts the view of technological rigidity facing developing countries, instead presents a large and dense range of alternative technologies available capable of producing grey-cloth. It further emphasises that the choice fo technology across the wage areas will vary,for instance technology suitable for UK (high wage area) when chosen for low wage area would sacrifice surplus,but / increase employment. 40/ However,as has been established by the author previously,this study also confirms that variations in profitability tends to be smaller across technologies than the corresponding variations in investment and employment, but trade-off between employment and profitability as suggested in the previous study is possibly less encouraging in this study. The study emphasises that there are choice available within the modern sector which vary across the wage rate. Economic effeciency can be achieved,if the proper choice is made. It has further been argued that increase in operating effeciency possibly through improvement in management practice could bring even greater gains than the uncritical choice. In such case, the least cost technology for high wage area could be suitably applied to low wage area and thus accrue identical surplus. It can finally be said, that this study identifies a range of alternatives in line with the ECLA study, however evaluation of alternatives in the latter was limited to only a few technologies and the choice of economic criteria was not as rigorous as in Pickett's study.

40/ ibid., table 8.1

Comparative Literature on the Organised and the Decentralised Sectors

The literature selected for discussion here attempts to make a comparative evaluation of both the organised and the decentralised sectors with particular attention to their economic effeciency and employment generation. In the face of growing unemployment in recent years, the debate raise is whether the developing countries should adopt modern production technology or should they continue with the traditional method of production or even perhaps develop a new 'intermediate technology to accomodate their own factor endowments and factor prices. It is relevant here to refer to the UNIDO Monograph - 6 (1979), which was published on the basis of the debate on 'Appropriate Technology for Textiles' which took place in 1978. The Monograph contains some valuable contributions of various authors.

Adhyaru and others have maintained that the choice of technology should be harmonised with the macro-economic strategy for development. 41/ Modern technology has failed to meet the national employment objective, although it has raised the aggregate level of production. Relative factor factor availability should be the major consideration of choice, and modern technology has many alternatives(as in the case of India) with different factor combinations. The criteria of choice should not be,according to them, economic surplus alone, capital intensive technology also needs to be justified from social point of view. They have argued that a developing country like India should continue with conventional technology in the organised sector, but stressed the need for better utilisation and modernisation. They have compared the conversion cost of conventional ring-spinning with advanced open-end spinning at Indian factor-costs and showed that the comparative advantage of open-end spinning diminishes steadily as the count becomes higher. 42/ They argue that the decentralised sector fulfils the social objective of providing employment because of

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41/ Evaluation of Appropriate Technology for Textile Production in a Developing Country, by the National Industrial Development Corporation Ltd, Indial, published by UNIDO,1978

42/ The cost of production for 10s cotton count for Ring Spinning is 80 per cent higher than Open-end, but for 28s cotton count it decreased to 23 per cent.

its favourable labour-capital ratio. 43/ It is also recognised that the wage cost per unit of output is high but the wage level at absolute terms are low. Such wage levels are acceptable only against the background of immense unemployment. They conclude that the combination of organised and decentralised sectors is important to sustain the present employment level. Furthermore, the model of centralising pre-spinning(up to the stage of roving frame) adopted by the Khadi and Village Industries Commission (KVIC) offers the possibility of combining the advantages of large and small scale operations. The final stages of spinning can be decentralised, with each of the spinning units consisting of one or more manually operated Ambar Charka. If Ambar charka can be power-operated then the productivity would increase further. Such harmonised combination could be successfully achieved with the help of a well-defined Government policy. The long term sustenance of the decentralised sector highlights the increase productivity and the quality of product which could be achieved through the development of this sector and through institutional support for product development and input and output marketing. Technological development should not imbalance the present capital-labour ratio, and should be achieved by marginal increase in equipment costs. Finally, the study draws the experiecne of the Indian decentralised sector and argues that it bears some important lesson for developing countries with similar socio-economic problems and with the intentions to expand their textile industry.

Sabhaney (1979) defines the problems of the textile industry as two-fold, one is socio-economic and the other technological. He sees the socio-economic problem as interdisciplinary, while the technological problem is one which deserves attention. He agrees with Adhyaru that, the suitability of open-end spinning is limited to 25s count yarn. Therefore, modernisation of conventional ring-frame would be more economic for developing countries. For weaving, he believes that the type of product in demand and the market size are responsible for making the shuttleless and the high-speed automatic looms unfavourable

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43/ The Capital/ Labour ratio for Ambar Charka , Ring and Open-end Spinning are 1 : 150 : 1350 , while for Handloom, Conventional automatic and Shuttleless looms they are 1 : 60 : 500 respectively.

compared to plain looms. 44/ Sabhaney maintains that,an intermediate technology which lies between a highly productive one of that of an industrially advanced country and a simple technology used in least developed country,would make the fullest use of available resources of a country. Such a technology should be adequately productive, economically viable and at the same time should not inhibit the growth in employment. The Government should protect the domestic textile machinery factory and should encourage development of technology which would suit the decentralise sector.

Boon expresses his opinion in similar lines with Sabhaney in emphasising the need for intermediate technology for the developing country.45/ He thought that the duality in development in the developing countries was due to the promotion of both high technology from the advanced countries and the traditional methods. He argues that a more balanced development could be accomplished by upgrading the technology of semi-urban areas. Some of the developing countries like Brazil, China, India which produce conventional machinery under licence and named as 'frozen technology', could be the source of such machinery. This intermediate technology could be viewed as parallel to the ECLA - and the UNIDO conventional technologies and to Pack's second-hand technology, but it would be a new technology to suit the factor prices and the endowments of the developing countries.
Along with similar line of argument put forward by the above authors, Bruce and Garg argues about the development of 'intermediate technology. 46/ But unlike them , Bruce and Garg 's concept of intermediate technology is meant to cater for the rural-sector only. The need for such technology arises from the fact that the handloom weavers face an extra cost of 25-30 per cent on yarn price when supplied by the organised sector. They maintain that,the supply of yarn by a seperate

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44/ The fabric length was found to be a determinant for selecting the type of loom. For high priced export quality flawless cloth of 200 meters length shuttleless loom is suitable. High speed semi-automatic looms would be suitable for high quality cloth of 40-80 meters in length. But as the market demand is for medium type of fabric,which are sold mostly in eter or in finsned piece cloth form, Plain lomms are most suitable.

45/ Dualism and Technological Harmony for Balanced Development of the Textile Industry, by Boon, G.K., UNIDO Monograph -6, op.cit.,pp 69-73

46/ Project Report and Feasibility Study on Appropriate Technology for Cotton Yarn Spinning on Cottage Basis in Rural Areas, op cit.

spinning unit or by cottage weavers as an integrated spinning unit could reduce the cost for the handloom weavers from 10 to 15 per cent and 20 to 22 per cent respectively. They point out that the technology used at the Khadi and Village Industry was inferior to meet the market quality and this had precipitated its failure. 47/ The developed technology should , therefore, provide an increase in productivity, quality product and be best suited for cottage level in terms of employment generation , organisational structure, infra-structural facilities, etc. They have further asserted that, although a small unit may be from economic stand-point at disadvantage with regard to labour and overhead cost but such disadvantages could be balanced by lower wage rate and investment cost,which could be 45 per-cent as compared to the organised sector. Bruce and Garg refer to the failure of the cooperatives to provide the required support to the handloom weavers because of financial and other constraints. They suggest an organisational pattern based on infra-structural facilities which would ensure a central supply of intermediate product (roving) [illegible] a 'Service Centre' to the cottage spinner both at integrated and seperate small cottage units and also ensure the marketing of their product. They further suggest the extension of central supply unit to provide processed warp beam to cottage weavers using ATDA developed pedal looms. This may increase the productivity of warping and sizing by 12 to 15 per cent and the income of the weavers by 7 to 10 per cent. An important aspect of this study,is the attempt of Appropriate Technology Development Association,India to develop such a ' Central Unit ' and improved cottage spinning machinery viz. 12 spindles pedal charka and 12 and 24 spindles power driven charka. The research presents some calculations on the feasibility of such a technology. It shows that,in an organised cottage spinning unit a spinner could earn between Rs.8 to 20 per day as wage if he is working on 24 to 72 spindles. The study recommends an unit size, which could produce 500 Kg(roving) and 300 Kg(beam) of intermediate products on 3 shifts basis for spinning and weaving respectively with an investment cost of Rs. 900 thousand. This would create a direct employ-

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47/ One of the principles in Khadi production is that it does not believe in the use of mechanised power in process levels. However, in recent years this principle has been relaxed and mechanised power is now introduced at the pre-spinning level.

ment of 21 and a total employment of 36 in the central unit, and would provide an employment of 150 for cottage spinners and about 150 to 200 for cottage weavers in the rural areas. It estimates the profitability of the unit on the basis of a project-life of 10 years at a capital cost of 11 per cent and presents a net return of 9.9 and 11.6 per cent for spinning and weaving respectively.48/ Unlike most other studies, Boon and Garg devote their findings on the rural sector and ignore completely the comparative advantages of the organised sector. They do not use any economic criteria to calculate the profitability and defend their technology choice purely on socio-economic grounds and employment growth.

It was Pickett and Robson who did the most systematic appraisal of both the organised and the decentralised sector (1979). 49/ The appraisal was undertaken with help of a well-defined economic criteria -- the Present Value Cost (PVC) and the Net Present Value (NPV). The relationship between technical economies, effeciency and employment was also taken into consideration. The study evaluates four possible alternative technologies and identifies the least cost technology at African wage rate. 50/ This technology is said to have an annual output of 28 million sq. yds. by combining Investment and Operative costs and discounting them at a capital cost of 10 and 20 per cent respectively. In organised sector,for spinning technology at 10 per cent capital cost PVC of open-end and ring spinning are almost the same, while at 20 per cent PVC , ring spinning has marginal advantage. In the case of weaving, the difference in PVC from the lowest to the highest order of 3-width automatic loom, non-automatic, Sulzer and single-width automatic looms, is more significant. The relationship between investment cost, profitability and employment shows that the difference in PVC is

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48/ While on a visit to this plant, it had been observed that a substantial amount of 'Sliver'(intermediate product) usually sold to the KVIC Institution, ~~which had been supplied to Khadi Ambar Rover and Spinner.~~ The profit of ATDA Service Centre mostly comes from the selling of Sliver.

49/ 'Production of Cotton With Special Reference to African Condition, by Pickett, J. and R. Robson, UNIDO Monograph -6, op. cit.,pp 19-40

50/ ibid., p.28

small but large for employment and the difference in the Investment costs are not negligible. At both discount rates, the combined technology of Ring-spinning and ordinary looms would be an economicall effecient choice. 51/ It would also have the lowest investment cost to provide the most employment. However, at medium wage-level the Open-end spinning and Sulzer looms become the least cost technology, but even then the difference in PVC remain very narrow. The lower scale of output is more likely to decrease profitibility i.e. if the scale of output is doubled profitablity remains the same, but at the lower level of output there is a significant change, which comes partly from higher adminstration. Reduction of the scale of operation by half will reduce the adminstration cost by only a quarter. Technical factors become important if the production falls below 28 million sq. yds. which happens when the Blow-room does not work on 3-shift basis. Assuming that labour can be deployed uniformly, the minimum level of output which could be attained on a shift basis is 1.75 million yards per annum(using 50 looms), while the increase in employment could be from 114 to 195 per million sq. yds. Below this level, the investment cost remain unchanged and labour would be deployed on single shift basis. The annual output would decrease to 0.6 million yds. and the PVC would increase by 79 per cent per sq. yds. 52/. At the minimum scale of output of 1.75 and 0.6 million yds per annum, it requires about 16 and 47 factories to achieve the comparative output level of 28.1 million sq.yd./a. This output if achieved by hand-spinning or hand-weaving then the minimum factory size required would be with 230 mechanised spindles and 26 handlooms producing 78,000 yds./A. At least 360 units are needed to match the comparable output of 28.1 m sq. yd./a. The PVC sq. yds. comes to $ 15.2, which is a four-fold increase in cost, however, the increase in employment by hand-operation is from

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51/ ibid., p.30

52/ Present Value Cost for 28.1 million yds of grey cotton cloth per annum comes to $ 3.73 per sq. yd., while for output of 1.75 million and 0.6 million sq. yds, they are $ 5.38 and $ 6.67 per sq.yd. repectively.

114 to 1,738/million sq. yds. . However, this calculations assumes an hourly wage rate same as for the modern mill, but if it assumes that in rural areas the wage rate is half of the modern sector, then hand-operation would be competitive with ordinary looms at or below an output level of 0.5 million sq. yds/annum. Employment would be much higher of 1,738/million sq. yds . compared to 195 per m.sq.yds for power looms. The study concludes that economic surplus should not be a single-minded approach to choose technology, therefore a compromise is between economic surplus and employment when maximising of employment is the policy objective, however proper weight should be attached to minimize the sacrifice of economic effeciency. Optimal technology desirable should have the properties of being the most profitable, the most-employment generating and the least demanding of investable funds. A case for an African country (with low wage rate)requiring an annual output of 28.1 million sq.yds. per annum, would select at 10 per cent capital-cost the option Ring- spinning and Ordinary loom from the alternatives available in the organised sector. The technologies,which are however not sensitive to the change in discount rate are rather more sensitive to the wage level. At medium wage level, the most cost intensive technology (Open-end spinning and Sulzer loom)becomes the least employment generating and the most profitable one but to choose the most labour-intensive one would only sacrifice profit to an extent of 5 per cent. The sacrifice in economic effeciency can be expressed in the form of an addition to investment cost, a decrease in NPV or an addition to PVC, and each of these can be expressed as either absolute -ly or as per additional job created. Among the four alternative technologies in the organised and the decentralised sectors capable of exploiting technical economies of scale, the findings show that between 1 modern and 16/small factories the trade-off between employment and profit ability cannot be accomodated with the surplus ,a decison to choose 16 factories rather than a single one would go beyond the sacrifice of positive profit into subsidy. The result suggest that, although small-scale is unattractive but alternative within the large scale could be attractive policy option example, even in a medium wage level, a loss of profit of 5 per cent could generate 160 per cent more employ -ment. 53/ Choice in the direction of small scale would depend great

53/ Net Present Value and Employment of most capital intensive technology is $ 9.5 million and 1,245 persons respectively, while labour-intensive technology has NPV and employment of $ 9 million and 3,209 persons respectively.

on the prices and the cost of production at which the alternatives are evaluated and requires much more macro and micro economic data. Finally, what are the policy options which may be adopted in an imperfect economy: if urban concentration of industry is ruled out to spread jobs elsewhere ? The report suggests that hand-operated technology would be preferable than the small-scale variant of power technology. In the case of 16 small factories where the discounted annual wage per operator is less than the cost per job(loss of NPV) it would be profitable to pay the additional worker the normal wage to stay away. But where hand-operated operation is concerned, the situation is reverse. If hand-operation is to be subsidised by imposing taxes on the customers than the price of cloth would rise by 70 per cent, this tax could be best realised by imposing it indirectly on finished goods. This could have the advantage of distributing tax according to income group and product and give no incentive to illicit traders.

A similar evaluation of the organised and the decentralised sectors was presented in a more detailed study by the same authors (1981).54/ This study also based the comparative annual output of 28 million sq. yds/a, and for small-scale modern factory production, it considers four different output level of 14, 7, 1.4, and 0.7 m.sq.yds/a and hand-operated factory with o.2 million sq.yds annual output. It further considers an output of 1.2 million sq. yds/a for a technology defined as 'intermediate technology' developed by the Appropriate Technology Development Association , India. The findings of this study is quite similar to that of their preceeding study. It concludes that the large 28 million sq. yds/a factory is economically superior to all the other alternatives considered. 55/ It also confirms in particular, the relative unattractiveness of the other ' modern ' mills(i.e small scale and hand-operated factories). However, considering the increase in PVC and job in combination, if the Government desires to give priority to employment, then

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54/ The Choice of Technology in Production of Cotton Cloth, op.cit., pp. 127-154.

55/ ibid., PVC/yd. and employment varies between modern,intermediate and hand operated factory for an annual output of 28 million sq. yd are $ 3.58, $ 4.74 and $ 6.55; and 2.223, 6,188 and 16,003 respectively.

then intermediate technology appears to be the most attractive one. Such choice would incur atleast 3 times more extra cost to create additional jobs in contrast to the modern least cost mills.

It would be relevant here to conclude this section by mentioning some of the recommendations forwarded at the International Forum on Appropriate Technology for the Production of Textiles,held in Delhi(1978). It was agreed that technology choice should be economi -cally viable by commercial criteria and should provide more employ -ment and require less use of scarce capital and finally, should contribute to income equality. Such a technology could be achieved by a combination of modern technology in the organised sector feeding the handloom sector, or by designing an appropriate machinery for hand-spinning involving atleast half of the capital cost of modern technology. An alternativeiin machinery sources could be the supply from developing countries of less sophisticated machinery which could be obtained at a lesser cost. Another alternative available for mak-ing small-scale or traditional technology commercially viable is the option that this sector should accept lower wages and receive Govern ment protection. Finally, the textile sector in the developing coun-tries requires a long-term policy for both the modern and the traditional sector.

Summary

It could be concluded from the literature above that there is no rigidity in technology choice and that there are a large number of alternatives available to choose from. Therefore the choice of technology is an emperical phenomenon. Technology choice in the production of textiles have been concentrated into these main areas : (a) the choice within the modern technology in the organised sector under large scale production; (b) the use of modern technology on a small-scale operation; (c) the use of recently developed 'intermedate technology ' in India for small-scale operation and (e) the use of traditional technologies in the rural sector. The literature on the organised sector establishes that within the modern sector, there is option for choice and these options, as has been concluded by different literatures, could be the use of conventional machinery (ECLA, UNIDO) obtainable from developing countries or second-hand machinery available at very low price (Pack, 1976) or even the use of recent machinery with different sub-process combination to achieve the least cost technology (Pickett, 1976 and '81). All these studies conclude that the variation of profitability is less sensitive to employment and trade-off is possible, and moreover, the employment gaind could be high as opposed to the sacrifice of profit. Hence, even though economic effeciency or re-investable surplus is important for growth and future employment generation, but to fulfil the developing strategy of many developed countries to create maximum employment, a small sacrifice of surplus could sometimes help to meet such objectives. Pack (1976) even speaks about the indirect benefit of employment of a magnitude much higher than the direct employment, which the second-hand technology of developed countries could generate. A more emphatic view on the adoption of modern technology has been put forward by Bhattacharya and Bhatia of the National Textile Corporation, India. He maintains that if the modern technology is to remain profitable under such circumstances the technology has to be advanced and labour-saving. 56/

56/ Technological Obsolescence of Indian Made Spinning Machinery, by Bhattacharya, H.P and S.K. Bhatia, National Textile Corporation Ltd., published in the Indian Textile Journal, August, 1982. It argues that two major items of input costs in spinning i.e. wage and power costs would increase from 19 and 17 per cent to 70 and 28 per cents respectively. The labour cost, which is one-fifth of the total manufacturing cost increses to two-third of the total cost.

The other literature which concerns both the modern small-scale operation, intermediate and Hand-operated technology agree unanimously on the relative advantage of moderntechnology organised in a large-scale operation. The small-scale operation was found to be functioning as economically disadvantaged units with the exception of providing only large employment. Pickett's study indicates a slight advantage of intermediate technology in comparison to modern small-scale operation. Hand-operated technology including both spining and weaving, has been regarded as a technology which operate only under subsidy. Sen has also emphasised the economic disadvantage of hand-operated spinning and concluded that the Ambar Charka programme is inflationary and is likely to affect capital accumulation adversely. 57/ However, the argument for continuing these technologies have been strengthened by the fact that the Ambar Charka already employs a large number of people in the developing countries and brings at least some kind of income. Under the present socio-economic circumstances, there are some schools of thought which argue that the decentralised sector should accept lower wages to make their technology economically viable. Both the UNIDO Monographs suggested a technology combination comprising of an organised modern sector supplying output to the decentralised handloom sector which may prove to be a better alternative to sustain the present level of employment in the developing countries under their present socio-economic condition. Such technology combination is already in operation in India and Bangladesh.

57/ Choice of Techniques, An Aspect of the Theory of Planned Economic Development, by Sen, A.K., Basil Blackwell, Oxford, 1972, Appendix-D pp. 93 -110.

Methodology of Evaluating Technology in the Process of Choice

The previous sections have established the scope of technology choice within a theoretical framework, and from the evidence derived from many textile studies it has been seen that the choice of techniques is possible within the organised and the decentralised sectors. Any systematic choice would, therefore, require a well defined methodology under which alternative production procedures are to be examined both from technical and economic consideration. The methodology will essentially contain techniques which will enable to identify the range of alternatives available for the production of a well-defined product, or detailed costing of the technically feasible techniques. It will also include a method of appraisal known as the Discounting Cash Flow method together with the criteria for selection and finally identification of data requirement to make such evaluation possible.

Identification of Alternate Technologies

The alternate production methods can be categorised in terms of technology and organisation. It is common in textile industry that the modern production method is always adopted by large factories and in an organised manner. It would be relevant therefore to place modern method of production under the organised sector. However, modern technology could be designed into small-scale operations, not concentrated in one place and this would then be defined as decentralised sector. The present study would, however, assume that the decentralised sector would use an intermediate technology which is developed in India but not as advanced as modern sector technology. Finally, the traditional technology, as for example handloom, if not adopted as organised production under factory shed condition but / could located at rural households/then be defined as Traditional sector. For the purpose of this study, the different technologies may be classified as follows :

i) Modern Technology - Organised Sector

ii) Intermediate Technology - Decentralised Sector

iii) Handloom Weaving - Traditional Sector

A complete textile process which has grey cloth as output consists of several sub-process operations viz. Opening and Cleaning of raw material, Carding, Drawing, Roving, Spinning, Cone-Winding, Pirn-Winding, Warping, Sizing and Weaving ,also known as Composite Unit. However, if the output is an intermediate product i.e yarn, then it is known as Spinning Unit and shares the same sub-processes with grey cloth upto Cone-Winding. From Cone-Winding onwards it includes two more operations Reeling and Bundling and Boiling. All these sub-processes are described in the appendix 3.1. A textile process can be combined either by complete modern technology, such as, modern Ring-Spinning and automatic loom or by intermediate developed spinning technology and ordinary power loom or by a combination of Hand-Spinning with pedal loom or handloom or even finally between Ring-Spinning and Handloom Weaving. Such combinations are technically feasible and quite common in many developing countries, however the economic effeciency may vary across the combinations.

Modern Technology

Modern method of textile production essentially consists of two kinds of spinning technology, Ring-Spinning and Open-end Spinning. While the weaving technology could vary from ordinary Lancashire automatic battery or unifil and pirnless of the type of Airjet, Rapier, projectile or multi-shuttle looms. These different teechnologies have a varying range of operating speed, for example , the speed in Ring-Spinning in general can be accelerated to a maximum of 16,000 rpm , while in Open-end Spinning it can run upto a maximum of 70,000 to 80,000 r.p.m. As regards weaving machinery, an ordinary Lancashire loom could have an weft insertion of 500 yds. per minute, while an Air-jet machine could have it upto 1500 yds/minute. It is evident that a process combination is possible with different technology levels and employment combinations. The earlier studies suggest that such combinations are possible to suit developing country conditions. These technology sources could be Conventional (ECLA, 1966), second-hand machinery (Pack, 1976) or even modern technology but with different sub-process options with different employment compliment (Pickett, 1981), combined to a numerous technology options. Also as suggested in the UNIDO Monograph-6 (1979) the sources

could be developing countries who produce Conventional machinery of the design now ceased to be produced by the developed countries. It can be said that in modern sector, technology option could either be then machinery from different sources or also as sub-process combination with different option at the sub-process level combined to a total technology. Such technology source may be considered as UK, Japan, Rumania and India. It is interesting to note that all these technologies are technically capable of operating at almost identical speeds, but their cost and labour compliment are liable to vary,however, the cost is more variable than the labour content.

Intermediate Technology

The concept of intermediate technology is not a very clear one. Some of the authors (Boon, 1976) have suggested that this technology need to be developed to accomodate the factor proportions and prices of the developing countries. This technology can be developed from the knowledge that has already been aquired in developing advanced machinery both in the developed and the developing countries. While Pack (1976) argues in favour of the use of second-hand machinery as an alternative to developing intermediate technology For the purpose of this study, intermediate technology may be defined as technology which is basically a rebuilt conventional one and at present available in India. There are also some manufacturers who produce older version of new machine for small-scale operations. Other type of 'intermediate technology' which has been advocated by the Appropriate Technology Association ,India is a completely new range of machinery which could be available for small-scale operations. However, such technology is still in the developing stage for the complete spinning process, although, the spinning machinery has been developed to suit cottage and small-scale operations. The cottage-scale version of the spinning machine consists of 12 spindles and are pedal or threadle operated, while the small-scale spinning frame could be upto 48 spindles driven by a small horse-power motor. These technologies are available from a number of sources in India and can operate both at cottage-level and small-scale factory unit, in conjunction with either hand , pedal or power loom. Another technology which is widely in opera-

tion in India and could be identified a// type of intermediate technology is the technology widely promoted by the Khadi and Village Industries Commission (KVIC). This spinning technology is known as ' KVIC Technology ' and consists of a complete range of pre-spinning viz. Opening and Cleaning (Purbo-Pesai), Carding, Drawing (Uttar Pesai) operations which are driven by power, while Roving and Spinning takes place by hand-operation. Roving and Spinning machinery are known as ' Ambar Charka ' and have 4 and 6 spindles with conventional drafting features. This technology in India, directly supplies the handloom weavers with yarn and in combination with it froms a complete process technology. Although the KVIC technology is of the cottage-type in nature, but they are organised under small-factory units in India and may therefore may be considered under the decentralised sector.

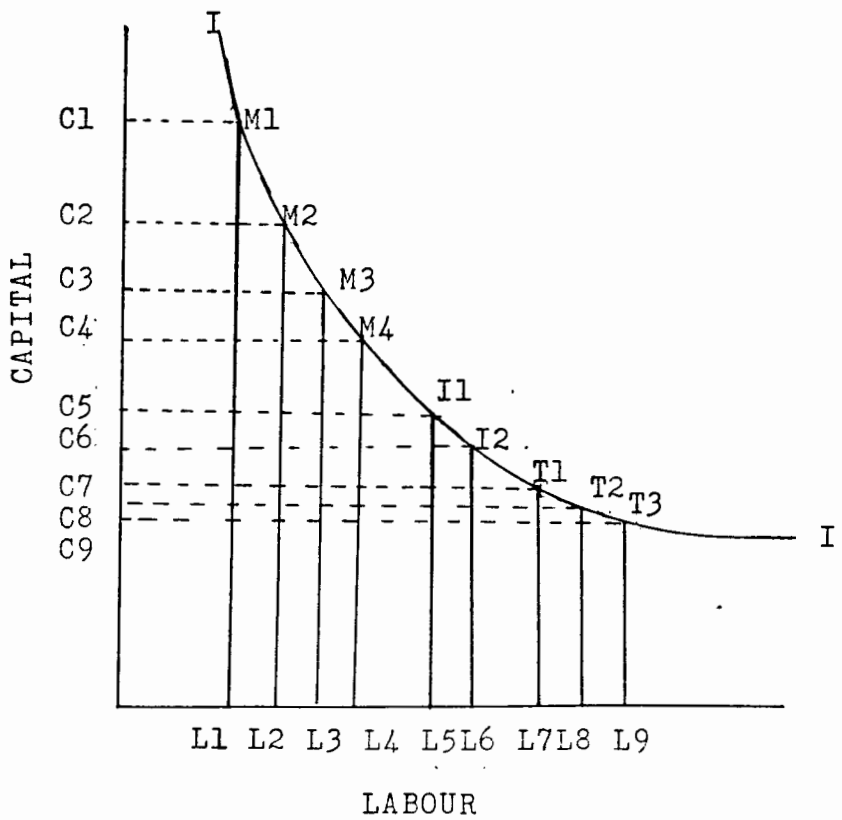
Handloom Weaving

Handloom weaving is mostly organised as a cottage unit and is a formidable industry both in India and Bangladesh. Traditionally, th yarn requirement of this industry was supplied by hand-spinning, however, with the advent of modern technology, the supplier role of hand-spinning has diminished considerably. In India it supplies only 1 per cent of the total yarn production , while in Bangladesh it is less than 0.5 per cent. In fact, in India , the handloom input is mainly supplied mainly by the organised sector, while the other technologies for example, Intermediate,Spinning and KVIC make some contributions. In Bangladesh, handloom is almost totally developed dependent on the organised sector for its yarn supply. Th types of handloom technology vary considerably, and as suggested earlier that there could be as many as 26 different varieties of handloom available in India. The types found in Bangladesh, on the other hand is limited, and there are mainly four types viz. Semi-Automatic, Fly-Through,Fly-Shuttle and Pit(See Chapter 2). Of the type concentrated in large numbers are Pit (62 per cent) and Semi-Automatic loom (23 per cent), they together contribute 85 per-cent of the total handloom capacity.

It could be arrived at from the discussions above that there are a number of alternative technology sources available within the

modern sector to produce a defined quality and quantity of output. Not only are there alternatives in sources, but alternatives at the sub-process level are also present with which it is possible to draw an Isoquant showing different technology options with different factor combinations. Furthermore, within the decentralised sector, it could be possible to combine Intermediate Spinning with power or pedal-loom Spinning in a small-factory condition and a number of such units could infact, meet the same output level as of the Organised sector using modern production methods. Alternatively, it is technically feasible and already in practice in many developing countries like India and Bangadesh to combine Organised(modern technology), Decentralised(Intermediate technology) and KVIC Spinning technology with the handloom. Such combination has also been advocated by UNIDO Monographs 6 and 7 (1969 and 1979). Assuming that all such technologies and their combinations can deliver a quantity of output Q, they have been depicted in terms of their factor proportions in figure 3.2 below :-

FIGURE 3.2



The Isoquant 1-1 shows a number of technically feasible technologies available for the production of an output Q. Across these technologies, the modern composite technology could be placed at the upper end of capital-labour ratio spectrum, which could be stated as M_1, M_2, M_3 and M_4 signifying sources from UK, Japan, Rumania and India. It may be noted that the capital component of these vary considerably and could be arranged in the order just described,while the labour component of the technologies do not vary significantly. The ' intermediate technology ' i.e a combination of intermediate spinning and power loom could be placed at I1, where the technology has less capital but more labour factor uses. There could be another combination of intermediate technology (I2) which synthesises pedal loom instead of power loom, and consequently uses more labour and capital resources. T_1 , T_2 and T_3 could be a combination of modern, intermediate and KVIC technologies with handloom weaving. The order of their placement has been based on the assumption that modern techlogy will require higher investment cost than the intermediate, and the intermediate would require higher than the KVIC when combined with handloom,and their employment,on the contrary would be lower in the same order. However a technology combination at E which uses more capital and labour would be considered as ineffecient as becaus it uses more of one factor without reducing the other.

Costing of Technologies

Once the technologies have been identified,it follows from there the costing of technically feasible alternatives. A detailed costing of the alternatives process is important for micro-economic search of technology. Pickett, Pack and ECLA studies have emphasised that a micro-economic search should combine all input cost, wastage level , skill compositon and other cost factors in order to arrive at a technology choice. Essentially this cost could be broadly divided into two cost categories : Investment and Operating Cost.

Investment Costs

Investment costs can be comprised of machinery and installation costs, building and infra-structural cost and some contingency for unforeseen expenditures. Machinery cost can consist of CIF or ex-factory cost depending on whether the machinery are imported or locally purchased, landing and handling charges where handling charges could be common to both local and imported machinery, while landing charges are only required for imported machinery. Duties and taxes form a component of machinery cost and depend on the country's tariff system, however account of such charges would also depend on the type of analysis intended , if for instance the evaluation method is to be financial then taxes and duties need to be taken into consideration. Whereas for an economic analysis , account of all taxes and subsidies would have to be excluded Transportation cost would depend on the location of the plant, if for example the plant is situated at a coastal location there would not be any transportation cost for imported machinery,whereas locally manufactured machinery would require transportation for moving the machiner from the factory site to the located plant. It would be appropriate to mention here that equipment which are locally produced for the rural sector would not have any tariff component and the transportation cost of these technologies could also be minimal.

Building and infra-structural costs could vary according to the technology. As for the Organised sector, the construction of building is usually of concrete floor, foundation and roof with brick walls. For a small scale factory as observed in India this construction could be the same but instead have a tin roof. The type of construction of the floor and the width of the wall could also vary. For handloom, it is most usual that these are not housed in a building as described for the Organised and the Decentralised sectors. They are mostly set up in houses without concrete floors having either thatched or tin roofs. Therefore, building costs vary considerably across the technologies. Another important aspect of building cost is the floor space required for different technologies These costs are more important when considering alternative sources of machinery,as for example, machinery from UK source may not require

identical floor space area as for Japan and other sources of machinery. Moreover, the machine production capacity for alternative sources may vary and in order to combine a complete process for a defined scale of output may require different number of machinery and different area. This could also be true when comparing modern and intermediate technologies. The intermediate process machinery are usually of low production capacity which demand a larger number of machinery at the sub-process level and hence more floor space. For the Traditional sector i.e handloom, this problem is not so acute.

Contingencies and other costs involve miscellaneous and unforeseen expenditures that may arise due to cost factors which were not already taken into account. Contingencies could accomodate any inflationary situation that may arise during the construction cost, while an example of the other costs could include the cost that may be incurred to expedite official matters at different levels.

Operating Cost

Operating cost consists of raw-material, sizing-material, fuel and power, spares, repairs and other costs. The raw-material cost could vary according to the waste level which accompanies the technologies. For a composite unit, the raw-material would be raw-cotton and the total raw-cotton input could differ in accordance with the characteristics of the cotton. Raw-cotton would constitute CIF cost, as almost 99 per cent of the total requirement of the country is imported (See 2.3.10). In addition to this cost there would landing and handling charges, transportation and other costs, which would depend on the location and the type of evaluations to be carried out. When the Organised or the Decentralised sector is supplying the handloom weavers then the input cost would be yarn at ex-factory cost including taxes and distribution cost and may consist of profit as well. It is relevant to mention here that cloth manufacture takes place in a composite unit, the input cost besides the raw-cotton cost, a tax on every pound of yarn which is used for cloth manufacturing. Sizing cost is required for composite units and handloom productions and is likely to vary for the Organised, Decentralised and the Dispersed sectors.

Among fuel and power cost, the most important is the power cost. Power cost may vary across the technology sources as well as at alternativ

sub-process level. It may also vary for modern and intermediate technologies, of which the latter consumes less power. It is appropriate to note here that in KVIC technology machinery upto Drawing operation consume power, while Ambar Charka (for Roving and Spinning) do not need any power. The Dispersed sector do not consume any power either. The cost of spares would also differ for different technologies and it could be reasonably assumed that for modern technology the spare would be imported, while for intermediate technology they may be locally available. Spares cost would include either CIF or ex-factory cost and additional cost viz. landing and handling charges, transportation cost, other costs and duties and taxes subject to whether they are imported or local and on the location of the plant and the type of evaluat on to be carried out. Spares for handlooms and other pre-weaving preparatory machinery are locally made and available at market price and do not include any transportation costs.

Wage cost is an important cost component and is an essential element in operating costs. Wage costs usually vary with productivity and skill composition. It would be relatively easier to identify the skill composition of the Organised sector where wages are already determined according to the skill formation. This wage rate could be used for alternative technologies in the modern sector. The wage rate of Intermediate and KVIC technologies would have been the best option for application if this sector had existed in Bangladesh. In the absence of such technology, it would be convenient to define the skill level at each sub-process and then use the modern sector wages. This skill composition should also take care of the productivity level, because an operative with identical skill may operate less number of machines. A spinnner for example, with almost identical skill may operate 48 spindles in the modern sector, whereas another spinner may operate upto 480 spindles in the organised sector. Wage rate for hand-spinning and handloom weaving may be used from the existing wages in these sectors. These wage rates could be the market wage rate and could be used for financial analysis. However, for an economic analysis, the opportunity cost or shadow price of labour is required. It it is assumed that the wage rate of skilled labour reflects the opportunity cost, then if an economic or price effeciency analysis is conducted, then derivation of shadow wage

rate for unskilled labour is only necessary.

Admisnistrative salaries at different levels of management may be used from the existing salary structure available in the Organised sector. This salary structure could be used for the Decentralised sector provided the level of management skills required in this sector can be established. This could depend on the size of the unit, the number of employment and on the organisation of the small-scale operations. Once the required management skill is defined then the slary structure of the Organised sector could be used. Administrative overheads, repairs and other miscellaneous costs need also to be estimated and have to be taken into account in order to arrive at the total operating cost.

Evaluation of Technologies by a Discounting Appraisal

The technology choice in this study would require a complete specification and costing of the alternatives. These issues have been dealt with in details in the earlier sections. It is therefore, now needful to select among the mutually exclusive alternative technologies those which seem to be the most appropriate on economic or social grounds.To achieve this, it would be necessary to decide on an appraisal method. If the investment is regarded as a choice between the present and the future, then it follows that a discount appraisal would be the most appropriate. The discount rate to be used should reflect the true cost of capital. This poses a problem in the case of developing countries where the market mechanism is not developed to reflect competitive situation. In such instance, it would be convenient to use different discount rates to relate their sensitivity with the profitability. Selection of a criterion or criteria is important for the appraisal, and there may be many investment criteria in use. Among them, the two frequently used criteria relevant for the present context are, Net Present Value (NPV) and the Internal Rate of Return (IRR). NPV is the sum of the disounted cost and revenue generated by a project during its life-time, while IRR is the rate of discount which would make the net present value of the project zero. In other words NPV gives net surplus, while the IRR gives the difference in the rate of return over the cost of the capital in the life time of the project.

$$NPV = \sum_{i=1}^{N} \frac{Ri - Ci}{(1 + d)^i}$$

Where, i = 1,2,3,4,5 ..... in year
N = Expected life of the project
Ri= Represent reveue in year i
Ci= Represents cost in year i
(Ri-Ci) = Represents Net Cash Flow in year i
d = Cost of capital
E = Sum of the present values of N net cash flow.

These criteria are related and each would provide a measure,whether to accept or reject a project at a given capital cost. However, they would give a different ranking of mutually exclusive projects. It would be required in the present context to make a choice among the criteria, and it is generally preferred among the economists to choose Net Present Value for measuring profitability when the emphasis is on the maximization of the surplus at a given discount rate.

For the purpose of the present study, it would be befitting to extend the measure of choice using the discounted cash-flow appraisal method. Such criteria could be used to assess besides the profitability criteria (NPV), the Present Value Cost of alternative technologies and the Present Value per unit of output.Both these measures are widely used by the David Livingstone Institute method of appraisal to identify the least cost technology and in several studies related to the choice of technology in Textiles.58/

58/ A Report on a Pilot Investigation of the Choice of Technology in Developing Countries, op.cit.,pp. 32-58

PVC essentially discounts all the cost elements of the project to its present value at a given rate of discount, while PVC per unit output only decides the PVC by the annual or total output. This can be illustrated with the help of the following formula ;-

$$PVC = \sum_{i=1}^{N} \frac{(Ki + Wi + Li + Mi + Ni) - Vi}{(1 + d)^{i}}$$

(See the back page of p.50 for notations)

If the quantity of output of each of the alternative technologies is fixed , the measure of PVC or PVC per unit of output technology would provide some important information, such as investable fund combined with the operating cost of each technology. The investabl fund of each technology is important in a developing economy, where capital is scarce due to low capital formation and savings. However, in these countries, the labour endowment is abundant. Therefore, technology choice would be aided if such information are available. A reference to the ECLA study could be made here, where increament of investable funds between conventional, intermediate and advanced technologies have been discussed. It shows that the increase in unit investment is proportionate to the increase in re-investable surplus for the intermediate and advanced technologies, but the ratio between the rise in the total investment needed and the rise in the re-investment surplus is more favourable at the intermedate level. 59/ The other direct benefit which be compared across the technologies is the employment generation of each of the alternatives. This together with the criteria would formalise any discussion on technology choice from among the alternatives and finally their ultimate choice.

59/ Choice of Technologies in the Latin American Textile Industries, op. cit., p. 45.

Data Requirement and Related Problems

To facilitate combining of the alternative technologies, detailed technical information and economic data are required. These data would include machine price of alternative sources of machinery viz. UK, Japan, Rumania and India, and their production capacity, recommended effeciency, power input, wastage level, floor space area, manning requirement , etc. For the modern sector, these information could be extracted from the manufacturer's price quotations and technical literatures. For intermediate and traditional technologies , these information are not as readily available as for the modern sector. For instance, the price of some of the intermediate machinery may vary considerably as these machines are sometimes re-built from the old ones to suit specific purposes. Opening and Cleaning, Carding, Roving and Sizing machines are sometimes re-built to meet specific conditions of production. Therefore, to establish a reasonably estimated cost , direct and detailed consultation is at times required with the machinery manufacturer. However, for some machinery prices and technical details are readily available, and these range of machinery could be Ring-Spinning, Section Warpimg, Pirn Winding and the Pedal or the Power loom. Handloom and pre-weaving machinery in the cottage sector, do not have any organised market and in fact are mostly built by local carpenters and tinsmiths. The prices of these machinery vary considerably and the life of these machinery is an important element in their pricing. It is essential to make a field observation in order to relate machinery prices with the type of equipment and to make the final estimate of their prices.

The data on the level of machine productivity and manning is very important. In the modern sector, the available literature only suggest the rated and expected production and the manning requirement. However, these technical parameters may not be appropriate for the specific country condition. Therefore , specific country data would be required to estimate themachinery and labour productivity. The problem does not end there when alternative sources of machinery are used, as they may experience different productivity level and their manning may well be different. Therefore

data requirement should take such factor into account. Another problem may arise from the fact that the data available may include machinery of older vintage , when ex-ante evaluation of alternatives considers new machinery prices and their rated and expected production. It is likely that new machinery are often designed for higher operating speed, therefore when estimating the production capacity of the new machinery at country condition,the direct use of the practised technology may not be appropriate and it would be essential to make adjustments for the differential operating speed. For intermediate technology, this problem is not so significant, as these machinery are built from the old conventional machinery and the role of technical progress rarely compliment any increase in production. For this technology, it is needful to make a careful observation of the practised technology in order to establish the estimated production level , manning requirement , power consumption, wastage level, etc.

The formidable problem which may arise when estimating the productivity and input costs of the handloom industry. The productivity may vary according to the type of equipment used, the use of such equipment varies considerably. Also in the traditional sector, shift working is not in practice and moreover there are seasonal as well as locational variations in existence. Therefore, the data on productivity should accomodate all these factors before estimating equipment and labour productivity. The cost of input may also vary according to the locations ,market accessibility and availability of working capital. In some cases, the types of inputs vary too, and all these need to be taken into account when establishing productivity level and input cost.

The maintenance of machinery and their prices may vary according to the technologies as for example the modern machinery would require a regular as well as preventive maintenance schedule, while intermediate technology would only need maintenance when there is a break-down. On the other hand, there may be very little maintenance for the traditional technologies. Furthermore, the break-down and repair may be less frequent for modern technology than for the intermediate and the traditional. These differential

maintenance and repairs would be reflected in their operating costs. Therefore, a detailed knowledge of the maintenance system and the type of repairs is essential.

For total investment cost,alongwith the price of local and imported machinery, the landing and handling charges, transportation and installation costs,and according to the appraisal method detailed information on taxes,and subsidies for different technologies are needed. As explained earlier, the construction of factory building and working shed for different technologies varies considerably and so also does their costs. A detailed construction cost would therefore be required for the alternative technologies.

Finally, the wage rate across is also expected to vary. It may be possible to estimate the wage rate for the modern sector as information on this sector is readily available. However, problem may arise in the case of intermediate technology if not initiated under public sector ownership in such event it may be arbitarily formed according to the local supply and demand condition. Further, the variation of wage rate according to the skill requirement is also important. Therefore, wage rate should accomodate such information. For the traditional sector, the wage rate may vary in accordance with location, type and market for the product and the type of operation. Information on wage rate for the traditional sector need to recognise these variations in order to establish an average wage rate.